*Competency 2.1* **Radiation protection personnel shall demonstrate an expert level knowledge of the Department of Energy (DOE) radiation protection system for occupational workers as set forth in the following policy, requirements and guidance documents:**

- **10 CFR 835, *Occupational Radiation Protection***
- **Implementation Guidance for use with 10 CFR 835**
- **DOE P 441.1, *Department of Energy Radiological Health and Safety Policy***
- **DOE N 441.2, *Radiological Protection for DOE Activities***

## 1. SUPPORTING KNOWLEDGE AND /OR SKILLS

a. Discuss the relationship of the above documents in defining the DOE system of radiation protection.
b. Give examples of how DOE P 441.1, *Department of Energy Radiological Health and Safety Policy* is reflected in requirements and guidance.
c. Explain how the 10 CFR 835 Implementation Guides are used to develop and implement local programs to comply with the radiation protection requirements at the site/facility level.
d. Discuss methods of meeting the key requirements in Subpart A (General Provisions). Include:
   - Scope and exclusions
   - Definitions
   - Radiological units
e. Discuss methods of meeting the key requirements in Subpart B (Radiation Protection Programs) based upon the guidance in the Radiation Protection Program Implementation Guide and the Occupational ALARA Program Implementation Guide, including:
   - Radiation protection program
   - Internal audits
f. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart C (Standards for Internal and External Exposure) based upon the guidance in the Internal Dosimetry Program Implementation Guide, the External Dosimetry Program Implementation Guide, the Radiation-Generating Devices Implementation Guide, and the Evaluation and Control of Fetal Exposure Implementation Guide, including:
   - Occupational limits for general employees
   - Combining internal and external dose equivalents resulting from DOE activities
   - Determination of compliance for nonuniform exposure of the skin
   - Limits for the embryo/fetus

- Limits for members of the public and minors entering a controlled area
- Concentrations of radioactive materials in air

g. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart E (Monitoring in the Workplace) based upon guidance in the External Dosimetry Program Implementation Guide, the Internal Dosimetry Program Implementation Guide, the Evaluation and Control of Fetal Exposure Implementation Guide, the Instrument Calibration for Portable Survey Instruments Implementation Guide, and the Workplace Air Monitoring Implementation Guide, including:
   - General monitoring requirements
   - Individual monitoring
   - Area monitoring
   - Radioactive contamination control and monitoring

h. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart F (Entry Control Program), including:
   - Radiological areas
   - High- and very high-radiation areas

i. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart G (Posting and Labeling) based upon the guidance in the Posting and Labeling for Radiological Control Implementation Guide, including:
   - General posting and labeling requirements
   - Controlled areas
   - Radiological areas

j. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart H (Records) based upon the guidance in the Occupational Radiation Protection Recordkeeping and Reporting Implementation Guide, including:
   - Individual monitoring records
   - Monitoring and workplace records
   - Administrative records

k. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart I (Reports to Individuals) based upon the guidance in the Occupational Radiation Protection Recordkeeping and Reporting Implementation Guide, including:
   - Annual dose report to monitored individuals
   - Termination report

l. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart J (Radiation Safety Training) based upon the guidance in the Radiation Safety Training Implementation Guide, including:
   - General employee training
   - Radiological worker training

- Radiological control technician training
- Other core training relevant to the employee's job

m. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart K (Design and Control) based upon the guidance in the Occupational ALARA Program Implementation Guide, including:
   - Design features, administrative controls, and procedural requirements
   - Facility design and modification
   - Control features

n. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart L (Releases of Materials and Equipment from Radiological Areas).

o. Discuss methods of meeting the key requirements in 10 CFR 835, Subpart N (Accidents and Emergencies), including:
   - General provisions
   - Emergency exposure situations
   - Nuclear accident dosimetry

p. Discuss methods of meeting the key requirements on administrative control levels, work authorizations, radiation safety training, posting, and control of sealed radioactive sources. Use the guidance in the Sealed Radioactive Source Accountability Implementation Guide to support the discussion on sealed source accountability.

q. Explain how the Radiation Control Technical Positions, 10 CFR 835 exemption decisions, and official interpretations of 10 CFR 835 are used to adapt the radiation protection requirements to unique conditions at DOE sites and facilities.

## 2. SUMMARY

### The Department of Energy (DOE) Directives System

The DOE Directives System includes a hierarchy of documents that describe how the Department does work. There are four levels of documents in the hierarchy:

- Policy (Why we do it)
- Requirements (What must be done)
- Guides (DOE acceptable methodologies)
- Technical standards (How to)

DOE P 441.1, *Department of Energy Radiological Health and Safety Policy* is the DOE policy for radiation protection. The policy of DOE is to adopt standards consistent with the recommendations of the International Committee on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP). ICRP and NCRP recommendations are formally codified into DOE requirements in 10 CFR 835, which carries the force of law. The provisions of 10 CFR 835 will provide the basis for the assessment of civil and criminal penalties under the Price-Anderson Amendments Act (PAAA) of 1988. However, 10 CFR 835 does not address all essential areas of radiation protection needed to form a comprehensive program for protection of individuals from ionizing radiation. The purpose of DOE N 441.2, *Extension of DOE N 441.1, Radiological Protection for DOE Activities*, is to supplement 10 CFR 835 in order to form a comprehensive radiation protection program (RAP).

Implementation Guides (IGs) provide an acceptable methodology for establishing and operating a RPP that will comply with DOE requirements specified in 10 CFR 835. Except for requirements mandated by regulation, contract, or administrative means, the provisions in the IGs are DOE's views on acceptable methods of program implementation and are not mandatory. Conformance with an IG will, however, create an inference of compliance with the related regulatory requirements. IGs are part of the Department's formal directives system.

Technical Standards establish work practices used by DOE to provide consistent guidance to DOE personnel and contractors on the levels of quality, safety, and reliability required for acceptable performance. There are two types of technical standards: Government and nongovernment. Government standards are prepared and maintained by agencies of the Federal government, like DOE. Nongovernment standards are prepared, coordinated, and published by standards writing bodies, such as the Institute of Electrical and Electronics Engineers (IEEE), the American Society for Testing and Materials (ASTM), the American Society of Mechanical Engineers (ASME), the

American National Standards Institute (ANSI), and the International Organization for Standardization (ISO). Technical standards are not enforceable as DOE requirements, unless explicitly implemented through regulations. They are contractually enforced if they are explicitly incorporated or referenced in a contract, an Order, or a program-specific requirements document that has been incorporated into a contract.

**DOE Policy in Requirements**

DOE Policy 441.1, *Department of Energy Radiological Health and Safety Policy* is the Department's policy to ensure that radiation exposures are maintained below regulatory limits and deliberate efforts are made to further reduce exposures and releases to as low as reasonably achievable (ALARA). DOE P 441.1 outlines the following priorities to meet this policy:

- DOE be consistent with national and international radiological protective standards
- Radiation workers are appropriately trained
- Technical competence with personnel responsible for oversight of the radiological control program
- Line management remains involved and accountable
- All radiological measurements, worker monitoring results, and public exposure estimates are accurate and appropriate
- Exposures are maintained ALARA
- Dose and waste reduction techniques are incorporated in the earliest planning stages
- Oversight is conducted in all radiological work practices

**Use of 10 CFR 835 Implementation Guides**

IGs are designed to assist DOE contractors in developing RPPs as required by 10 CFR 835. IGs identify the requirements of 10 CFR 835 that relate to specific major topical areas and provide guidance on the characteristics of a RPP that the Department considers sufficient to comply with regulatory requirements. The RPP documentation should reflect the programmatic requirements for accomplishing 10 CFR 835 compliance. All Implementation Guidance for use with Title 10, Code of Federal Regulations, Part 835 can be found on the Worker Protection Programs Homepage at:

*http://tis-nt.eh.doe.gov/whs/whs.html-ssi*

**10 CFR 835, *Occupational Radiation Protection***

10 CFR 835, *Occupational Radiation Protection* is found, in its entirely, on pages RP 2.1-5 to RP 2.1-26, with the omission of the entire Appendices. Comments to the regulation are included in shade boxes and are not a part of the 10 CFR 835.

Subpart A, General Provisions

835.1 Scope

(a) General. The rules in this part establish radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities.
(b) Exclusion. The requirements in this part do not apply to:
  (1) Activities that are regulated through a license by the Nuclear Regulatory Commission or a State under an Agreement with the Nuclear Regulatory Commission, including activities certified by the Nuclear Regulatory Commission under section 1701 of the Atomic Energy Act;
  (2) Activities conducted under the authority of the Director, Naval Nuclear Propulsion Program, as described in Public Law 98-525;
  (3) Activities conducted under the Nuclear Explosives and Weapons Safety Program relating to the prevention of accidental or unauthorized nuclear detonations; or
  (4) Background radiation, radiation doses received as a patient for the purposes of medical diagnosis or therapy, or radiation doses received from voluntary participation in medical research programs.

835.2 Definitions.

(a) As used in this part:
  Airborne radioactive material or airborne radioactivity means radioactive material in any chemical or physical form that is dissolved, mixed, suspended, or otherwise entrained in air.

  Airborne radioactivity area means any area where the measured concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed 10 percent of the derived air concentration (DAC) values listed in appendix A or appendix C of this part.

  ALARA means as low as reasonably achievable, which is the approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. As used in this part, ALARA is not a dose limit but a

process which has the objective of attaining doses as far below the applicable limits of this part as is reasonably achievable.

Ambient air means the general air in the area of interest (e.g., the general room atmosphere), as distinct from a specific stream or volume of air that may have different properties.

Annual limit on intake (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man (ICRP Publication 23) that would result in a committed effective dose equivalent of 5 rems (0.05 sievert) or a committed dose equivalent of 50 rems (0.5 sievert) to any individual organ or tissue. ALI values for intake by ingestion and inhalation of selected radionuclides are based on Table 1 of the U.S. Environmental Protection Agency's Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, published September 1988. This document is available from the National Technical Information Service, Springfield, VA.

Background means radiation from:

(i) Naturally occurring radioactive materials which have not been technologically enhanced;

(ii) Cosmic sources;

(iii) Global fallout as it exists in the environment (such as from the testing of nuclear explosive devices);

(iv) Radon and its progeny in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities; and

(v) Consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation.

Bioassay means the determination of kinds, quantities, or concentrations, and, in some cases, locations of radioactive material in the human body, whether by direct measurement or by analysis, and evaluation of radioactive materials excreted or removed from the human body.

Calibration means to adjust and/or determine either:

(i) The response or reading of an instrument relative to a standard (e.g., primary, secondary, or tertiary) or to a series of conventionally true values; or

(ii) The strength of a radiation source relative to a standard (e.g., primary, secondary, or tertiary) or conventionally true value.

Contamination area means any area where contamination levels are greater than the values specified in appendix D of this part, but less than or equal to 100 times those levels.

Continuous air monitor (CAM) means an instrument that continuously samples and measures the levels of airborne radioactive materials on a "real-time" basis and has alarm capabilities at preset levels.

Contractor means any entity under contract with the Department of Energy with the responsibility to perform activities at a DOE site or facility.

Controlled area means any area to which access is managed in order to protect individuals from exposure to radiation and/or radioactive material. Individuals who enter only the controlled area without entering radiological areas are not expected to receive a total effective dose equivalent of more than 100 mrem (0.001 sievert) in a year.

Declared pregnant worker means a woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational exposure limits to the embryo/fetus as provided in § 835.206. This declaration may be revoked, in writing, at any time by the declared pregnant worker.

Derived air concentration (DAC) means, for the radionuclides listed in Appendix A of this part, the airborne concentration that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2,000 hours (assuming a breathing volume of 2,400 $m^3$). For the radionuclides listed in Appendix C of this part, the air immersion DACs were calculated for a continuous, non-shielded exposure via immersion in a semi- infinite atmospheric cloud. The value is based upon the derived airborne concentration found in Table 1 of the U.S. Environmental Protection Agency's Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, published September 1988. This document is available from the National Technical Information Service, Springfield, VA.

DOE activities means an activity taken for or by the DOE that has the potential to result in the occupational exposure of an individual to radiation or radioactive material. The activity may be, but is not limited to, design, construction, operation, or decommissioning. To the extent appropriate, the activity may involve a single DOE facility or operation or a combination of facilities and operations, possibly including an entire site.

Entrance or access point means any location through which an individual could gain access to areas controlled for the purposes of radiation protection. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

General employee means an individual who is either a DOE or DOE contractor employee; an employee of a subcontractor to a DOE contractor; or a visitor who performs work for or in conjunction with DOE or utilizes DOE facilities.

High contamination area means any area where contamination levels are greater than 100 times the values specified in appendix D of this part.

High radiation area means any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Individual means any human being.

Member of the public means an individual who is not occupationally exposed to radiation or radioactive material. An individual is not a "member of the public" during any period in which the individual receives occupational exposure.

Minor means an individual less than 18 years of age.

Monitoring means actions intended to detect and quantify radiological conditions.

Nonstochastic effects means effects due to radiation exposure for which the severity varies with the dose and for which a threshold normally exists (e.g., radiation-induced opacities within the lens of the eye).

Occupational exposure means an individual's exposure to ionizing radiation (external and internal) as a result of that individual's work assignment. Occupational exposure does not include planned special exposures, exposure received as a medical patient, background radiation, or voluntary participation in medical research programs.

Person means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency, any State or political subdivision of, or any political entity within a State, any foreign government or nation or other entity, and any legal successor, representative, agent or agency of the foregoing; provided that person does not include the Department or the United States Nuclear Regulatory Commission.

Radiation means ionizing radiation: alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation as used in this part, does not include non ionizing radiation, such as radiowaves, microwaves, or visible, infrared, or ultraviolet light.

Radiation area means any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates.

Radiological area means any area within a controlled area which must be posted as a "radiation area," "high-radiation area," "very high-radiation area," "contamination area," "high-contamination area," or "airborne radioactivity area" in accordance with § 835.603.

Radiological worker means a general employee whose job assignment involves operation of radiation producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year total effective dose equivalent.

Representative, as applied to the sampling of radioactive material, means sampling in such a manner that the sample closely approximates both the amount of activity and the physical and chemical properties of the material (e.g., particle size and solubility in the case of air sampling of the aerosol to which workers may be exposed).

Stochastic effects means malignant and hereditary diseases for which the probability of an effect occurring, rather than its severity, is regarded as a function of dose without a threshold for radiation protection purposes.

Survey means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Very high radiation area means any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at 1 meter from a radiation source or from any surface that the radiation penetrates.

Year means the period of time beginning on or near January 1 used to determine compliance with the provisions of this part. The starting date of the year used to determine compliance may be changed provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

(b) As used in this part to describe various aspects of radiation dose:

Absorbed dose (D) means the energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

Collective dose means the sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-sievert).

Committed dose equivalent (HT,50) means the dose equivalent calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or sievert).

Committed effective dose equivalent (HE,50) means the sum of the committed dose equivalents to various tissues in the body (HT,50), each multiplied by the appropriate weighting factor (wT)- i.e., HE,50 = SigmawTHT,50. Committed effective dose equivalent is expressed in units of rem (or sievert).

Cumulative total effective dose equivalent means the sum of the total effective dose equivalents recorded for an individual for each year of employment at a DOE or DOE contractor site or facility, effective January 1, 1989.

Deep dose equivalent means the dose equivalent derived from external radiation at a depth of 1 cm in tissue.

Dose equivalent (H) means the product of absorbed dose (D) in rad (or gray) in tissue, a quality factor (Q), and other modifying factors (N). Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert).

Effective dose equivalent (HE) means the summation of the products of the dose equivalent received by specified tissues of the body (HT) and the appropriate weighting factor (wT)-i.e., HE = SigmawTHT. It includes the dose from radiation sources internal and/or external to the body. The effective dose equivalent is expressed in units of rem (or sievert).

External dose or exposure means that portion of the dose equivalent received from radiation sources (e.g., "external sources") outside the body.

Extremity means hands and arms below the elbow or feet and legs below the knee.

Internal dose or exposure means that portion of the dose equivalent received from radioactive material taken into the body (e.g., "internal sources").

Lens of the eye dose equivalent means the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 cm.

Quality factor means the principal modifying factor used to calculate the dose equivalent from the absorbed dose; the absorbed dose (expressed in rad or gray) is multiplied by the appropriate quality factor (Q).

(i) The quality factors to be used for determining dose equivalent in rem are shown below:

**Quality Factors**

| **Radiation Type** | **Quality Factor** |
|---|---|
| X-rays, gamma rays, positrons, electrons (including tritium beta particles) | 1 |
| Neutrons, < or = 10 keV | 3 |
| Neutrons, > 10 keV | 10 |
| Protons and singly-charged particles of unknown energy with rest mass greater than one atomic mass unit | 10 |
| Alpha particles and multiple charged particles (and particles of unknown charge) of unknown energy | 20 |

When spectral data are insufficient to identify the energy of the neutrons, a quality factor of 10 shall be used.

(ii) When spectral data are sufficient to identify the energy of the neutrons, the following mean quality factor values may be used:

## QUALITY FACTORS FOR NEUTRONS

(Mean quality factors, Q [maximum value in a 30-cm dosimetry phantom], and values of neutron flux density that deliver in 40 hours, a maximum dose equivalent of 100 mrem [0.001 sievert].)

| Neutron Energy | Mean Quality | Neutron Flux Density |
|---|---|---|
| $2.5x10^{-8}$ thermal | 2 | 680 |
| $1x10^{-7}$ | 2 | 680 |
| $1x10^{-6}$ | 2 | 560 |
| $1x10^{-5}$ | 2 | 560 |
| $1x10^{-4}$ | 2 | 580 |
| $1x10^{-3}$ | 2 | 680 |
| $1x10^{-2}$ | 2.5 | 700 |
| $1x10^{-1}$ | 7.5 | 115 |
| $5x10^{-1}$ | 11 | 27 |
| 1 | 11 | 19 |
| 2.5 | 9 | 20 |
| 5 | 8 | 16 |
| 7 | 7 | 17 |
| 10 | 6.5 | 17 |
| 14 | 7.5 | 12 |
| 20 | 8 | 11 |
| 40 | 7 | 10 |
| 60 | 5.5 | 11 |
| $1x10^{2}$ | 4 | 14 |
| $2x10^{2}$ | 3.5 | 13 |
| $3x10^{2}$ | 3.5 | 11 |
| $4x10^{2}$ | 3.5 | 10 |

Shallow dose equivalent means the dose equivalent deriving from external radiation at a depth of 0.007 cm in tissue.

Total effective dose equivalent (TEDE) means the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). For purposes of compliance with this part, deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures.

Weighting factor ($w_T$) means the fraction of the overall health risk, resulting from uniform, whole body irradiation, attributable to specific tissue (T). The dose equivalent to tissue, T, is multiplied by the appropriate weighting factor to obtain the effective dose equivalent contribution from that tissue. The weighting factors are as follows:

**Weighting Factors For Various Tissues**

| Organs or Tissues, T | Weighting Factor, $w_T$ |
|---|---|
| gonads | 0.25 |
| breasts | 0.15 |
| red bone marrow | 0.12 |
| lungs | 0.12 |
| thyroid | 0.03 |
| bone surface | 0.03 |
| remainder[1] | 0.30 |
| whole body[2] | 1.00 |

{1}"Remainder" means the five other organs or tissues with the highest dose (e.g., liver, kidney, spleen, thymus, adrenal, pancreas, stomach, small intestine, and upper large intestine). The weighting factor for each remaining organ or tissue is 0.06.
{2}For the case of uniform external irradiation of the whole body, a weighting factor (wT) equal to 1 may be used in determination of the effective dose equivalent.

Whole body means, for the purposes of external exposure, head, trunk (including male gonads), arms above and including the elbow, or legs above and including the knee.

(c) Terms defined in the Atomic Energy Act and not defined in this part are used consistent with the meanings given in the Act.

(d) As used in this part, words in the singular also include the plural and words in the masculine gender also include the feminine and vice versa, as the case may be.

835.3 General rule

(a) No person or DOE personnel shall take or cause to be taken any action inconsistent with the requirements of:
  (1) This part; or
  (2) Any program, plan, schedule, or other process established by this part.
(b) With respect to a particular DOE activity, contractor management shall be responsible for compliance with the requirements of this part.
(c) Where there is no contractor for a DOE activity, DOE shall ensure implementation of and compliance with the requirements of this part.
(d) Nothing in this part shall be construed as limiting actions that may be necessary to protect health and safety.

835.4 Radiological units

Unless otherwise specified, the quantities used in the records required by this part shall be clearly indicated in special units of curie, rad, or rem, including multiples and subdivisions of these units. The SI units, becquerel (Bq), gray (Gy), and sievert (Sv), are only provided parenthetically in this part for reference with scientific standards. These SI units are not authorized for use in records required under this part.

Subpart B, Radiation Protection Programs

Subpart B Discussion

The documented RPP includes all of the documents describing and implementing the program to provide protection of individuals against ionizing radiation and radioactive materials. These include policies, plans, schedules, and procedures developed and implemented to achieve ans ensure compliance with 10 CFR 835 and to apply the ALARA process. The RPP is the document satisfying 10 CFR 835.101 (c-f) as approved by DOE. It is intended that the RPP serve as a bridging document between the rule and the implementing policies and procedures. DOE is asked to approve the RPP as a bridge, but not the policies and procedures themselves, unless invoked as part of the RPP. DOE will verify the adequacy of the bridge during its review and approval of the RPP. This bridging document is an Implementation Plan for a Nuclear Safety Rule, and therefore is enforceable as a Nuclear Safety Requirement. As a result of the DOE approval process, it can serve as a "permit as a shield" against external misassessments as to compliance.

The rule requires an internal audit of all functional elements of the program, no less than, every 36 months. This internal audit program should be aggressive, and should cover the more critical functional elements more frequently than that. DOE is relying upon contractor internal audits in lieu of a thorough and extensive DOE external oversight program. 10 CFR 820 provides reduced Price-Anderson Act penalties for early self-identification, reporting, and correction of noncompliances.

835.101 Radiation protection programs

(a) A DOE activity shall be conducted in compliance with a documented radiation protection program (RPP) as approved by the DOE.
(b) The DOE may direct or make modifications to an RPP.
(c) The content of each RPP shall be commensurate with the nature of the activities performed and shall include formal plans and measures for applying the as low as reasonably achievable (ALARA) process to occupational exposure.
(d) The RPP shall specify the existing and/or anticipated operational tasks that are intended to be within the scope of the RPP. Except as provided in § 835.101(I), any task outside the scope of an RPP shall not be initiated until an update of the RPP is approved by DOE.
(e) The content of the RPP shall address, but shall not necessarily be limited to, each requirement in this part.
(f) The RPP shall include plans, schedules, and other measures for achieving compliance with regulations of this part. Compliance with this part shall be achieved no later than January 1, 1996.
(g) The RPP for an existing activity shall be submitted to DOE no later than January 1, 1995.
(h) An update of the RPP shall be submitted to DOE:
    (1) Whenever a change or an addition to the RPP is made;
    (2) Prior to the initiation of a task not within the scope of the RPP; or
    (3) Within 180 days of the effective date of any modifications to this part.
(i) Changes, additions, or updates to the RPP may become effective without prior Department approval only if the changes do not decrease the effectiveness of the RPP and the RPP, as changed, continues to meet the requirements of this part. Proposed changes that decrease the effectiveness of the RPP shall not be implemented without submittal to and approval by the Department.
(j) An initial RPP or an update shall be considered approved 180 days after its submission unless rejected by DOE at an earlier date.

835.102 Internal audits

Internal audits of all functional elements of the radiation protection program shall be conducted no less frequently than every three years and shall include program content and implementation.

Subpart C, Standards for Internal and External Exposure

835.201 [Reserved]

835.202 Occupational exposure limits for general employees

Section 835.202 Note:

External Dose Determination

Personnel dosimeter measurements and associated external dose evaluations are the primary method for demonstrating compliance with external component of dose limits for protecting workers. The measurement system should comply with the requirements of the Department of Energy Laboratory Accreditation Program for Personnel Dosimetry (DOELAP).

Internal Dose Determination

Biokinetic models should be used to interpret bioassay data and assess initial radionuclide intake. Bioassay data is the primary input for internal dose evaluations. Methods of evaluating the committed dose equivalent form internal sources of radiation should be appropriate to the workplace conditions and should be specified in the internal dosimetry technical basis document. Methods for evaluating various doses from the technical basis document should be consistent with EPA, NCRP, and ICRP recommendations and DOE good practices.

(a) The occupational exposure to general employees resulting from DOE activities, other than planned special exposures under § 835.204 and emergency exposure situations under § 835.1302, shall be controlled so the following annual limits are not exceeded:
  (1) A total effective dose equivalent of 5 rems (0.05 sievert);
  (2) The sum of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye of 50 rems (0.5 sievert);
  (3) A lens of the eye dose equivalent of 15 rems (0.15 sievert); and
  (4) A shallow dose equivalent of 50 rems (0.5 sievert) to the skin or to any extremity.

(b) All occupational exposure received during the current year shall be included when demonstrating compliance with § 835.202(a).

(c) Exposures from background, therapeutic and diagnostic medical radiation, and voluntary participation in medical research programs shall not be included in dose records or in the assessment of compliance with the occupational exposure limits.

835.203 Combining internal and external dose equivalents resulting from DOE activities

(a) The total effective dose equivalent during a year shall be determined by summing the effective dose equivalent from external exposures and the committed effective dose equivalent from intakes during the year. For purposes of compliance with this part, deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures.

(b) Determinations of the effective dose equivalent shall be made using the weighting factor values provided in § 835.2.

(c) For the case of uniform external irradiation of the whole body, a weighting factor ($w_T$) equal to 1 may be used in the determination of the effective dose equivalent.

835.204 Planned special exposures

(a) A planned special exposure may be authorized for a radiological worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in § 835.202(a), provided that each of the following conditions is satisfied:
  (1) The planned special exposure is considered only in an exceptional situation when alternatives that might prevent a radiological worker from exceeding the limit in § 835.202(a)(1) are unavailable or impractical;
  (2) The contractor management (and employer, if the employer is not the contractor) specifically requests the planned special exposure, in writing; and
  (3) Joint written approval from the appropriate DOE Headquarters program office and the Assistant Secretary for Environment, Safety and Health is received.

(b) Prior to requesting an individual to participate in an authorized planned special exposure, the individual's dose from all previous planned special exposures and all doses in excess of the occupational dose limits shall be determined.

(c) An individual shall not receive a planned special exposure that, in addition to the doses determined in § 835.204(b), would result in a dose exceeding the following:
  (1) A total effective dose equivalent of 5 rems (0.05 sievert) in the current year; and
  (2) A cumulative total effective dose equivalent of 25 rems (0.25 sievert).

(d) Prior to a planned special exposure, written consent shall be obtained from each individual involved. Each individual shall be:
  (1) Informed of the purpose of the planned operations and procedures to be used;
  (2) Informed of the estimated doses and associated potential risks and specific radiological conditions and other hazards which might be involved in performing the task; and
  (3) Instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present.

(e) Records of the conduct of a planned special exposure shall be maintained and a written report submitted within 30 days after the planned special exposure to the approving organizations identified in § 835.204(a)(3).

(f) The dose from planned special exposures is not to be considered in controlling future occupational dose of the individual under § 835.202(a), but is to be included in records and reports required under this part.

835.205 Determination of compliance for non-uniform exposure of the skin

(a) Nonuniform exposures of the skin from x-rays, beta radiation, and/or radioactive material on the skin are to be assessed as specified in this section.

(b) For purposes of demonstrating compliance with § 835.202(a)(4), assessments shall be conducted as follows:

(1) Area of skin irradiated is 100 $cm^2$ or more. The non-uniform dose equivalent received during the year shall be averaged over the 100 $cm^2$ of the skin receiving the maximum dose, added to any uniform dose equivalent also received by the skin, and recorded as the shallow dose equivalent to any extremity or skin for the year.

(2) Area of skin irradiated is 10 $cm^2$ or more, but is less than 100 $cm^2$. The non-uniform dose equivalent (H) to the irradiated area received during the year shall be added to any uniform dose equivalent also received by the skin and recorded as the shallow dose equivalent to any extremity or skin for the year. H is the dose equivalent averaged over the 1 $cm^2$ of skin receiving the maximum absorbed dose, D, reduced by the fraction f, which is the irradiated area in $cm^2$ divided by 100 $cm^2$ (i.e., H = fD). In no case shall a value of f less than 0.1 be used.

(3) Area of skin irradiated is less than 10 $cm^2$. The non-uniform dose equivalent shall be averaged over the 1 $cm^2$ of skin receiving the maximum dose. This dose equivalent shall:
   (i) Be recorded in the individual's occupational exposure history as a special entry; and
   (ii) Not be added to any other shallow dose equivalent to any extremity or skin recorded as the dose equivalent for the year.

835.206 Limits for the embryo/fetus

(a) The dose equivalent limit for the embryo/fetus from the period of conception to birth, as a result of occupational exposure of a declared pregnant worker, is 0.5 rem (0.005 sievert).

(b) Substantial variation above a uniform exposure rate that would satisfy the limits provided in § 835.206(a) shall be avoided.

(c) If the dose equivalent to the embryo/fetus is determined to have already exceeded 0.5 rem (0.005 sievert) by the time a worker declares her pregnancy, the declared pregnant worker shall not be assigned to tasks where additional occupational exposure is likely during the remaining gestation period.

835.207 Limits for minors

Any minor exposed to radiation and/or radioactive material during direct onsite access at a DOE site or facility shall not exceed 0.1 rem (0.001 sievert) total effective dose equivalent in a year.

835.208 Limits for members of the public entering a controlled area

Any member of the public exposed to radiation and/or radioactive material during direct onsite access at a DOE site or facility shall not exceed 0.1 rem (0.001 sievert) total effective dose equivalent in a year.

835.209 Concentrations of radioactive material in air

(a) The derived air concentration (DAC) values given in appendices A and C to this part shall be used in the control of occupational exposures to airborne radioactive material.
(b) With regard to inhalation exposures and external exposures from airborne radionuclides, compliance with this part shall be demonstrated through conformity with § 835.101 and § 835.202 which establishes the applicable regulatory limits.
(c) The estimation of internal dose shall be based on bioassay data rather than air concentration values unless bioassay data are:
    (1) unavailable;
    (2) inadequate; or
    (3) internal dose estimates based on representative air concentration values are demonstrated to be as or more accurate.

Subpart D (Reserved)

Subpart E Monitoring in the Workplace

835.401 General requirements

(a) Monitoring of individuals and areas shall be performed to:
    (1) Demonstrate compliance with the regulations in this part;
    (2) Document radiological conditions in the workplace;
    (3) Detect changes in radiological conditions;
    (4) Detect the gradual buildup of radioactive material in the workplace; and
    (5) Verify the effectiveness of engineering and process controls in containing radioactive material and reducing radiation exposure.
(b) Area monitoring in the workplace shall be routinely performed, as necessary, to identify and control potential sources of personnel exposure to radiation and/or radioactive material.
(c) Instruments used for monitoring and contamination control shall be:
    (1) Periodically maintained and calibrated on an established frequency of at least once per year;
    (2) Appropriate for the type(s), levels, and energies of the radiation(s) encountered;
    (3) Appropriate for existing environmental conditions; and
    (4) Routinely tested for operability.

835.402 Individual monitoring

(a) For the purpose of monitoring individual exposures to external radiation, personnel dosimetry shall be provided to and used by:
  (1) Radiological workers who, under typical conditions, are likely to receive one or more of the following:
    (i) An effective dose equivalent to the whole body of 0.1 rem (0.001 sievert) or more in a year;
    (ii) A shallow dose equivalent to the skin or to any extremity of 5 rems (0.05 sievert) or more in a year;
    (iii) A lens of the eye dose equivalent of 1.5 rems (0.015 sievert) or more in a year;
    (iv) A deep dose equivalent from external exposures to any organ or tissue other than the lens of the eye of 5 rems (0.05 sievert);
  (2) Declared pregnant workers who are likely to receive from external sources a dose equivalent to the embryo/fetus in excess of 10 percent of the applicable limit in § 835.206;
  (3) Minors and members of the public likely to receive, in 1 year, from external sources, a dose in excess of 50 percent of the applicable limits in § 835.207 or § 835.208, respectively; or
  (4) Individuals entering a high or very high radiation area.

(b) Personnel external dosimetry programs shall be adequate to demonstrate compliance with § 835.202, including routine dosimeter calibration and conformance with the requirements of the DOELAP.

(c) For the purpose of monitoring individual exposures to internal radiation, internal dose evaluation programs (including routine bioassay programs) shall be conducted for:
  (1) Radiological workers who, under typical conditions, are likely to receive 0.1 rem (0.001 sievert) or more committed effective dose equivalent, and/or 5 rems (0.05 sievert) or more committed dose equivalent to any organ or tissue, from all occupational radionuclide intakes in a year;
  (2) Declared pregnant workers likely to receive an intake resulting in a dose equivalent to the embryo/fetus in excess of 10 percent of the limit stated in § 835.206; or
  (3) Minors and members of the public who are likely to receive, in 1 year, an intake resulting in a committed effective dose equivalent in excess of 50 percent of the limits stated in § 835.207 or § 835.208, respectively.

(d) Internal dose evaluation programs shall be adequate to demonstrate compliance with § 835.202.

835.403 Area monitoring

(a) Measurements of radioactivity concentrations in the ambient air of the workplace shall be performed as follows:
  (1) Air sampling shall be performed in occupied areas where, under typical conditions, an individual is likely to receive an annual intake of 2 percent or more of the specified ALI values. For a given radionuclide and lung retention class, the ALI is the product of the DAC listed in appendix A of this part and the constant $2.4 \times 10^9$ ml. Samples shall be taken as necessary to detect and evaluate the level or concentration of airborne radioactive material at work locations.
  (2) Real-time air monitoring, using continuous air monitors as defined in § 835.2, shall be performed in normally occupied areas where an individual is likely to be exposed to a concentration of airborne radioactivity exceeding 1 DAC as specified in appendix A of this part or where there is a need to alert potentially exposed individuals to unexpected increases in airborne radioactivity levels.
  (3) For the airborne radioactive material that could be encountered, real-time air monitors shall have alarm capability and sufficient sensitivity to alert potentially exposed individuals that immediate action is necessary in order to minimize or terminate inhalation exposures.
(b) Monitoring of radiation in the workplace shall be performed using stationary (area) or portable radiation instruments, or a combination thereof. The instruments shall be readily available and shall be capable of measuring ambient radiation dose rates for the purpose of controlling radiation exposures.

835.404 Radioactive contamination control and monitoring

(a) Instruments and techniques used for radioactive contamination monitoring and control shall be adequate to ensure compliance with the requirements specified in this section.
(b) Appropriate controls shall be maintained and verified which prevent the inadvertent transfer of removable contamination to locations outside of radiological areas under normal operating conditions.
(c) Any area in which contamination levels exceed the values specified in Appendix D of this part shall be:
  (1) Posted in accordance with § 835.603; and
  (2) Controlled in a manner commensurate with the physical and chemical characteristics of the contaminant, the radionuclides present, and the fixed and removable contamination levels.
(d) Areas with fixed contamination exceeding the total radioactivity values specified in Appendix D of this part may be located outside of radiological areas provided the following conditions are met:
  (1) Removable contamination levels are below the levels specified in Appendix D of this part;
  (2) Unrestricted access to the area is not likely to cause any individual to receive a total effective dose equivalent in excess of 0.1 rem (0.001 sievert) in a year;

(3) The area is routinely monitored;
(4) The area is clearly marked to alert personnel of the contaminated status;
(5) Appropriate administrative procedures are established and exercised to maintain control of these areas; and
(6) Dose rates do not exceed levels which would require posting in accordance with § 835.603.

(e) Entry control pursuant to § 835.501 and posting pursuant to 835.603 are not required for areas with fixed contamination meeting the conditions of 835.404(d).
(f) Appropriate monitoring to detect and prevent the spread of contamination shall be performed by individuals exiting radiological areas established to control removable contamination and/or airborne radioactivity.
(g) Protective clothing shall be required for entry to areas in which removable contamination exists at levels exceeding those specified in Appendix D to this part.

Subpart F Entry Control Program

835.501 Radiological areas

(a) Personnel entry control shall be maintained for each radiological area.
(b) The degree of control shall be commensurate with existing and potential radiological hazards within the area.
(c) One or more of the following methods shall be used to ensure control:
(1) Signs and barricades;
(2) Control devices on entrances;
(3) Conspicuous visual and/or audible alarms;
(4) Locked entrance ways; or
(5) Administrative controls.
(d) Administrative procedures shall be written as necessary to demonstrate compliance with the provisions of this section. These administrative procedures shall include actions essential to ensure the effectiveness and operability of barricades, devices, alarms, and locks. Authorizations shall be required to perform specific work within the area and shall include specific radiation protection measures.
(e) No control(s) shall be installed at any radiological area exit that would prevent rapid evacuation of personnel under emergency conditions.

835.502 High- and very high- radiation areas

(a) High-radiation areas. One or more of the following features shall be used for each entrance or access point to a high-radiation area where radiation levels exist such that an individual could exceed a deep dose equivalent to the whole body of 1 rem (0.01 sievert) in any one hour at 30 centimeters from the source or from any surface that the radiation penetrates:
  (1) A control device that prevents entry to the area when high-radiation levels exist or upon entry causes the radiation level to be reduced below that level defining a high-radiation area;
  (2) A device that functions automatically to prevent use or operation of the radiation source or field while personnel are in the area;
  (3) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry;
  (4) Entryways that are locked. During periods when access to the area is required, positive control over each entry is maintained;
  (5) Continuous direct or electronic surveillance that is capable of preventing unauthorized entry;
  (6) A control device that will automatically generate audible and visual alarm signals to alert personnel in the area before use or operation of the radiation source and in sufficient time to permit evacuation of the area or activation of a secondary control device that will prevent use or operation of the source.
(b) Very high-radiation areas. In addition to the above requirements, additional measures shall be implemented to ensure individuals are not able to gain access to very high-radiation areas when dose rates are in excess of the posting requirements of § 835.603(c).
(c) No control(s) shall be established in a high- or very high-radiation area that would prevent rapid evacuation of personnel.

Subpart G Postings

835.601 General requirements

(a) Working areas that require posting because of the presence, or potential presence, of radiation and/or radioactive material are delineated in the subsequent paragraphs of this section. Radioactive items or containers of radioactive materials, shall be individually labeled if adequate warning is not provided by control measures and required posting.
(b) DOE approved signs, labels, and radiation symbols shall be used to identify areas specified in this subpart.
(c) Required signs and labels shall have a yellow background. The radiation symbol shall be black or magenta.
(d) Signs required by this subpart shall be clear and conspicuously posted and may include radiological protection instructions.

(e) The posting requirements in this section may be modified to reflect the special considerations of DOE activities conducted at private residences. Such modifications shall provide the same level of protection to individuals as the existing provisions in this section.

835.602 Controlled areas

(a) Each access point to a controlled area (as defined in § 835.2) shall be posted, identifying it as a controlled area, whenever radioactive material and/or radiation fields which would require posting under § 835.603 may be present in the area.
(b) Signs used for this purpose may be selected by the contractor to avoid conflict with local security requirements.

835.603 Radiological areas

Each access point to a radiological area (as defined in § 835.2) shall be posted with conspicuous signs bearing the wording provided in this section.

(a) Radiation Area. The words "Caution, Radiation Area" shall be posted at any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates.
(b) High-Radiation Area. The words "Danger, High-Radiation Area" shall be posted at any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.
(c) Very High-Radiation Area. The words "Grave Danger, Very High-Radiation Area" shall be posted at any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at 1 meter from the radiation source or from any surface that the radiation penetrates.
(d) Airborne Radioactivity Area. The words "Caution, Airborne Radioactivity Area" shall be posted for any occupied area in which airborne radioactivity levels exceed, or are likely to exceed, 10 percent of the DAC value listed in Apendix A or Apendix C of this part.
(e) Contamination Area. The words "Caution, Contamination Area" shall be posted where contamination levels exceed values listed in Apendix D of this part, but are less than or equal to 100 times those values.
(f) High-Contamination Area. The words "Danger, High-Contamination Area" shall be posted where contamination levels are greater than 100 times the values listed in Apendix D of this part. Radiation signs must be a magenta or black trefoil on a yellow background.

Subpart H, Records

835.701 General provisions

(a) Records shall be maintained to document compliance with this part and with radiation protection programs required by § 835.101.
(b) Unless otherwise specified in this subpart, records shall be retained until final disposition is authorized by DOE.

835.702 Individual monitoring records

(a) Records shall be maintained to document doses received by all individuals for whom monitoring was required pursuant to § 835.402 and doses received during planned special exposures, accidents, and emergency conditions.
(b) The results of individual external and internal dose measurements that are performed, but are not required by § 835.402, shall be recorded. Recording of the nonuniform shallow dose equivalent to the skin caused by contamination on the skin (see § 835.205) is not required if the dose is less than 2 percent of the limit specified for the skin in § 835.202(a)(4).
(c) The records required by this section shall:
    (1) Be sufficient to evaluate compliance with § 835.202;
    (2) Be sufficient to provide dose information necessary to complete reports required by subpart I of this part and by Departmental requirements for occurrence reporting and processing;
    (3) Include the following quantities for external dose received during the year:
        (i) The effective dose equivalent from external sources of radiation (deep dose equivalent may be used as effective dose equivalent for external exposure);
        (ii) The lens of the eye dose equivalent;
        (iii) The shallow dose equivalent to the skin; and
        (iv) The shallow dose equivalent to the extremities.
    (4) Include the following quantities for internal dose resulting from intakes received during the year:
        (i) Committed effective dose equivalent;
        (ii) Committed dose equivalent to any organ or tissue of concern; and
        (iii) Estimated intake and identity of radionuclides.
    (5) Include the following quantities for the summation of the external and internal dose:
        (i) Total effective dose equivalent in a year;
        (ii) For any organ or tissue assigned an internal dose during the year, the sum of the deep dose equivalent from external exposures and the committed dose equivalent to that organ or tissue; and
        (iii) Cumulative total effective dose equivalent received from external and internal sources while employed at the site or facility, since January 1, 1989.

(6) Include the dose equivalent to the embryo/fetus of a declared pregnant worker.

(d) Documentation of all occupational exposure received during the current year shall be obtained when demonstrating compliance with 835.202(a). In the absence of formal records of previous occupational exposure during the year, a written estimate signed by the individual may be accepted.

(e) Efforts shall be made to obtain records of prior years occupational internal and external exposure.

(f) The records specified in this section that are identified with a specific individual shall be readily available to that individual.

(g) Data necessary to allow future verification or reassessment of the recorded doses shall be recorded.

(h) All records required by this section shall be transferred to the DOE upon cessation of activities at the site that could cause exposure to individuals.

835.703 Monitoring and workplace records

The following information shall be documented and maintained:

(a) Results of surveys for radiation and radioactive material in the workplace as required by §§ 835.401, 835.403, and 835.404;

(b) Results of surveys, measurements, and calculations used to determine individual occupational exposure from external and internal sources;

(c) Results of surveys for the release of material and equipment as required by § 835.1101(d); and

(d) Results of maintenance and calibration performed on:

(1) Instruments used for area monitoring and contamination control as required by § 835.401; and

(2) Devices used for individual monitoring as required by §§ 835.401 and 835.402.

835.704 Administrative records

(a) Training records shall be maintained, as necessary, to demonstrate compliance with §§ 835.901, 835.902, and 835.903.

(b) Actions taken to maintain occupational exposures as low as reasonably achievable, including the actions required for this purpose by § 835.101, as well as facility design and control actions required by §§ 835.1001, 835.1002, and 835.1003, shall be documented.

(c) Records shall be maintained to document the results of internal audits and other reviews of program content and implementation.

(d) Written declarations of pregnancy shall be maintained.

(e) Changes in equipment, techniques, and procedures used for monitoring in the workplace shall be documented.

Subpart I, Reports to Individuals

835.801 Reports to individuals

(a) Radiation exposure data for individuals monitored in accordance with § 835.402 shall be reported as specified in this section. The information shall include the data required under § 835.702(c). Each notification and report shall be in writing and include: the DOE site or facility name, the name of the individual, and the individual's social security number or employee number.
(b) Upon the request from an individual terminating employment, records of exposure shall be provided to that individual as soon as the data are available, but not later than 90 days after termination. A written estimate of the radiation dose received by that employee based on available information shall be provided at the time of termination, if requested.
(c) Each DOE- or DOE-contractor-operated site or facility shall, on an annual basis, provide a radiation dose report to each individual monitored during the year at that site or facility in accordance with § 835.402.
(d) Detailed information concerning any individual's exposure shall be made available to the individual upon request of that individual, consistent with the provisions of the Privacy Act (5 U.S.C. 552a).
(e) When a DOE contractor is required to report to the Department, pursuant to Departmental requirements for occurrence reporting and processing, any exposure of an individual to radiation and/or radioactive material, or planned special exposure in accordance with 835.204(e), the contractor shall also provide that individual with a report on his or her exposure data included therein. Such report shall be transmitted at a time not later than the transmittal to the Department.

Subpart J,Radiation Safety Training

835.901 General employees

(a) All general employees shall be trained in radiation safety prior to receiving occupational exposure during access to controlled areas at a DOE site or facility. Allowance may be made for previous DOE training on generic radiation safety topics (i.e., those not specific to a site or facility), provided the training was received at another DOE site or facility within the past 2 years. Documentation of the previous training shall clearly identify the individual's name, date of training, topics covered, and name of the certifying individual. The knowledge of radiation safety possessed by general employees shall be verified by examination.
(b) Retraining shall be provided when there is a significant change to radiation protection policies and procedures that affect general employees and shall be conducted at intervals not to exceed 2 years.

835.902 Radiological workers

Radiological worker training programs and retraining shall be established and conducted at intervals not to exceed 2 years to familiarize the worker with the fundamentals of radiation protection and the ALARA process. Training shall include both classroom and applied training. Training shall either precede assignment as a radiological worker or be concurrent with assignment as a radiological worker if the worker is accompanied by and under the direct supervision of a trained radiological worker. Radiological worker training not specific to a given site or facility may be waived provided that: this training has been received at another DOE site or facility within the past 2 years; there is provision of proof-of-training in the form of a certification document containing the individual's name, date of training, and specific topics covered; and an appropriate official has certified the training of the individual. The knowledge of radiation safety possessed by radiological workers shall be verified by examination prior to an unsupervised assignment. The training shall include procedures specific to an individual's job assignment. The level of training is to be commensurate with each worker's assignment.

835.903 Radiological control technicians

Training and retraining programs for radiological control technicians shall be established and conducted at intervals not to exceed 2 years to familiarize technicians with the fundamentals of radiation protection and the proper procedures for maintaining exposures ALARA. This program shall include both classroom and applied training. The training shall either precede performance of tasks assigned to radiological control technicians or be concurrent with such task assignments if the individual is accompanied by and under the direct supervision of a trained individual. The required level of knowledge of radiation safety possessed by radiological control technicians shall be verified by examination to include demonstration prior to any unsupervised work assignment. The training program shall include procedures specific to the site or facility where the technician is assigned. The level of training shall be commensurate with the technician's assignment. Allowance may be made for previous DOE training on generic radiation safety topics (i.e., those not specific to a site or facility), provided the training was received within the past 2 years. Documentation of the previous training shall clearly identify the individual's name, date of training, topics covered, and name of the certifying individual.

Subpart K Design and Control

835.1001 Design and control

(a) Measures shall be taken to maintain radiation exposure in controlled areas as low as is reasonably achievable through facility and equipment design and administrative control. The primary methods used shall be physical design features (e.g., confinement, ventilation, remote handling, and shielding). Administrative controls and procedural requirements shall be employed only as supplemental methods to control radiation exposure.
(b) For specific activities where use of physical design features are demonstrated to be impractical, administrative controls and procedural requirements shall be used to maintain radiation exposures ALARA.

835.1002 Facility design and modifications

During the design of new facilities or modification of old facilities, the following objectives shall be adopted:
(a) Optimization methods shall be used to assure that occupational exposure is maintained ALARA in developing and justifying facility design and physical controls.
(b) The design objective for controlling personnel exposure from external sources of radiation in areas of continuous occupational occupancy (2,000 hours per year) shall be to maintain exposure levels below an average of 0.5 mrem (5 microsieverts) per hour and as far below this average as is reasonably achievable. The design objectives for exposure rates for potential exposure to a radiological worker where occupancy differs from the above shall be ALARA and shall not exceed 20 percent of the applicable standards in § 835.202.
(c) Regarding the control of airborne radioactive material, the design objective shall be, under normal conditions, to avoid releases to the workplace atmosphere and in any situation, to control the inhalation of such material by workers to levels that are ALARA; confinement and ventilation shall normally be used.
(d) The design or modification of a facility and the selection of materials shall include features that facilitate operations, maintenance, decontamination, and decommissioning.

835.1003 Control procedures

(a) During routine operations, the combination of design features and administrative control procedures shall provide that:
    (1) The anticipated magnitude of the total effective dose equivalent shall not exceed 5 rems (0.05 sievert) in a year;

(2) The anticipated magnitude of the committed dose equivalent to any organ or tissue, plus any deep dose equivalent from external exposure, shall not exceed 50 rems (0.5 sievert) in a year; and
(3) Exposure levels are as low as reasonably achievable.

(b) Compliance with the requirements in paragraph (a) of this section shall be demonstrated by appropriate monitoring pursuant to the provisions of subpart E.

Subpart L Releases of Materials and Equipment from Radiological Areas

835.1101 Releases of materials and equipment from radiological areas

The following requirements apply for the release of materials and equipment from radiological areas for use in controlled areas:

(a) In radiological areas established to control surface or airborne radioactive material, material and equipment shall be treated as radioactive material and shall not be released from radiological areas to controlled areas if either of the following conditions exist:
(1) Measurements of accessible surfaces show that either the total or removable contamination levels exceed the values specified in Appendix D to this part; or
(2) Prior use suggests that the contamination levels on inaccessible surfaces are likely to exceed the values specified in Appendix D to this part.

(b) Material and equipment exceeding the total or removable contamination levels specified in Appendix D to this part may be conditionally released for movement onsite from one radiological area for immediate placement in another radiological area only if appropriate monitoring and control procedures are established and exercised.

(c) Material and equipment with fixed contamination levels that exceed the limits specified in Appendix D to this part may be released for use in controlled areas outside of the radiological areas with the following provisions:
(1) Removable contamination levels are below the level specified in Appendix D of this part; and
(2) Materials shall be routinely monitored, clearly labeled, or tagged to alert personnel of the contaminated status; appropriate administrative procedures shall be established and exercised to maintain control of these items.

(d) The records for release of material and equipment shall describe the property, date on which the release survey was performed, identity of the individual who performed the survey, type and identification number of the survey instrument used, and results of the survey.

Subpart M, [Reserved]

Subpart N, Accidents and Emergencies

835.1301 General provisions

(a) A general employee whose occupational exposure has exceeded any of the limits specified in §§ 835.202 or 835.205 may be permitted to return to work in radiological areas during the current year providing that all of the following conditions are met:
  (1) Approval is first obtained from the contractor management and the Head of the responsible DOE field organization;
  (2) The individual receives counseling from radiological protection and medical personnel regarding the consequences of receiving additional occupational exposure during the year; and
  (3) The affected employee agrees to return to radiological work.
(b) All exposures exceeding the limits specified in §§ 835.202 or 835.205 shall be recorded in the affected individual's occupational exposure file and reported to the DOE in accordance with Departmental requirements for occurrence reporting and processing.
(c) When the conditions under which the emergency or accident exposures were received have been eliminated, operating management shall notify the Head of the responsible DOE field organization.
(d) Operations after an emergency or accidental exposure in excess of the limits specified in §§ 835.202 or 835.205 may be resumed only with the approval of the DOE.
(e) Occurrence reports to DOE regarding emergencies and/or accidents shall be prepared and submitted in accordance with Departmental requirements for occurrence reporting and processing.

835.1302 Emergency exposure situations

(a) The risk of injury to those individuals involved in rescue and recovery operations shall be minimized.
(b) Operating management shall weigh actual and potential risks to rescue and recover individuals against the benefits to be gained.
(c) Rescue action that might involve substantial personal risk shall be performed by volunteers.
(d) The dose limits for individuals performing these operations are as follows:

**Guidelines for Control of Emergency Exposures**

| Dose Limit[1] (Whole Body) | Activity Performed | Conditions |
|---|---|---|
| 5 rems | All | |
| 10 rems | Protecting major property | Where lower dose limit not practicable |
| 25 rems | Lifesaving or protection of large populations | Where lower dose limit not practicable |
| >25 rems | Lifesaving or protection of large populations | Only on a voluntary basis to personnel fully aware of the risks involved |

[1] The lens of the eye dose limit is three times the listed values. The shallow dose limit to the skin of the whole body and the extremities is ten times the listed values. These doses are in addition to and accounted for separately from the doses received under the limits in §§ 835.202 and 835.205.

(e) Each individual selected shall be trained in accordance with § 835.902 and briefed beforehand of the known or anticipated hazards to which the individual will be subjected.

835.1303 [Reserved]

835.1304 Nuclear accident dosimetry

(a) Installations possessing sufficient quantities of fissile material to potentially constitute a critical mass, such that the excessive exposure of personnel to radiation from a nuclear accident is possible, shall provide nuclear accident dosimetry for those personnel.
(b) Nuclear accident dosimetry shall include the following:
  (1) A method to conduct initial screening of personnel involved in a nuclear accident to determine whether significant exposures to radiation occurred;
  (2) Methods and equipment for analysis of biological materials;
  (3) A system of fixed nuclear accident dosimeter units; and
  (4) Personal nuclear accident dosimeters worn by all personnel who enter locations in which installed criticality alarm systems are required.

**Table 2**
**Surface Radioactivity Values**

| Nuclide | Removable (dpm/100 $cm^2$) | Total (Fixed + Removable) (dpm/100 $cm^2$) |
|---|---|---|
| U-natural, U-235, U-238, and associated decay products | 1,000 | 5,000 |
| Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129 | 20 | 500 |
| Th-natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133 | 200 | 1,000 |
| Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above. | 1,000 | 5,000 |
| Tritium Organic Compounds; surfaces contaminated by HT, HTO, and metal tritide aerosols. | [Reserved] | [Reserved] |

DOE N441.2, *Radiological Protection for DOE Activities* is a notice which extends DOE N441.1 unless sooner rescinded. The contents of N441.1 have been incorporated in the draft revision of 10 CFR 835, and will be rescinded when the amendment reissued as a final rulemaking. DOE N441.1 is provided in its entirety on pages RP 2.1-27 to RP 2.1-31.

**DOE N 441.1, *Radiological Protection for DOE Activities***

The Department of Energy (DOE) undertook an initiative to reduce the burden of unnecessary, repetitive, or conflicting requirements on DOE contractors that resulted in the elimination of numerous radiological protection requirements which were invoked via DOE Orders and Notices. The majority of pertinent radiological protection requirements have become codified through promulgation of Title 10 of the Code of Federal Regulations, Part 835, *Occupational Radiation Protection* (10 CFR 835). However, 10 CFR 835 does not address all essential areas, such as sealed radioactive source accountability, needed to form the basis of a comprehensive program for protection of individuals from the hazards of ionizing radiation in controlled areas.

The purpose of issuing this Notice is to establish radiological protection program requirements that, combined with 10 CFR 835 and its associated implementation guidance, form the basis for such a comprehensive radiological protection program. Accordingly, the Directives Management Board established DOE concurrence on a set of 16 top-level, performance-based requirements that are now incorporated in this Notice. These 16 requirements supplement and enhance the requirements of 10 CFR 835 to provide critical direction in the areas of administrative controls, radiation safety training, work authorizations, posting, exposure of minors, and sealed radioactive source accountability.

1. PURPOSE: To establish radiological protection program requirements that, combined with 10 CFR 835 and its associated implementation guidance, form the basis for a comprehensive program for protection of individuals from the hazards of ionizing radiation in controlled areas. These requirements shall remain in effect pending completion of the Department's rulemaking efforts to codify these, or equivalent, requirements.

2. CANCELLATION: The Orders listed below are canceled. Cancellation of an Order does not, by itself, modify or otherwise affect any contractual obligation to comply with such an Order. Canceled Orders that are incorporated by reference in a contract shall remain in effect until the contract is modified to delete the reference to the requirements in the canceled Orders.

    a. DOE 5480.11, *Radiation Protection for Occupational Workers*
    b. DOE 5480.15, *DOE Laboratory Accreditation Program for Personnel Dosimetry*
    c. DOE N 5400.13, *Sealed Radioactive Source Accountability*
    d. DOE N 5480.11, *Extension of Radiological Control Manual*, Revision 1 (DOE *Radiological Control Manual* (DOE/EH-0256T) remains as guidance)

3. APPLICABILITY:

   a. DOE Elements. Except for the exclusions in paragraph 3c, this Notice applies to all defense nuclear facilities (defined in 10 CFR 830, as amended) classified as hazard categories 1, 2, or 3 which are subject to the requirements of 10 CFR 835.
   b. Contractors. Except for the exclusions in paragraph 3c, this Notice applies to contractors that operate defense nuclear facilities and other contractors as determined by the cognizant contracting officer. Contractor compliance with this Notice will be required to the extent set forth in a contract. Contractors shall be directed to continue to comply with the requirements of Orders canceled by this Notice until their contracts are modified to delete the reference to the requirements of the canceled Orders.
   c. Exclusions. Activities conducted under the authority of the Director, Naval Nuclear Propulsion Program, as described in Public Law 98-525.

4. BACKGROUND: The need for interim requirements for implementation of radiological protection programs arises from recent Departmental efforts to revise and streamline its directives system. The Department has identified certain requirements previously promulgated in the DOE Radiological Control Manual and DOE N 5400.13, *Sealed Radioactive Source Accountability*, and recommendations of recognized scientific organizations that it believes are crucial to the accomplishment of its radiological protection objectives. This Notice establishes interim requirements for radiological protection programs that will remain in effect pending completion of the Department's rulemaking efforts to codify these, or equivalent, requirements. Other provisions, previously promulgated in the *DOE Radiological Controls Manual* and standards referenced therein, are considered acceptable methods to satisfy 10 CFR 835 and its associated Implementation Guides. Alternative methods to those contained in the Implementation Guides which provide equivalent margins of protection in satisfying the requirements of 10 CFR 835 are also acceptable.

5. DEFINITIONS.

   Terms used in this Notice are consistent with their definitions in 10 CFR 835. The following additional terms and definitions are provided:

   a. Accountable sealed radioactive source means a sealed radioactive source having an activity equal to or greater than the applicable value provided in Attachment 1 of this Notice.
   b. Administrative control level means a numerical dose constraint established at a level below the occupational exposure limits provided in 10 CFR 835 to administratively control and help reduce individual and collective doses.
   c. Radiological work permit means an authorization to conduct work involving exposure to radiation or radioactive materials that identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals.

d. Sealed radioactive source means a radioactive source specifically manufactured, obtained, or retained for the purpose of utilizing the emitted radiation. The sealed radioactive source consists of a known quantity of radioactive material contained within a sealed capsule, sealed between layers of nonradioactive material, or firmly fixed to a non-radioactive surface by electroplating or other means intended to prevent leakage or escape of the radioactive material.
e. Source integrity test means a test to determine if a sealed radioactive source is leaking radioactive material.
f. Technical work document means a formally approved document that directs work, such as a procedure, work package, laboratory protocol, or job or research plan and that also identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals.

6. REQUIREMENTS.

a. Administrative Control Levels

A system of administrative control levels (ACLs) shall be implemented to control radiological worker doses at levels below the occupational exposure limits provided in 10 CFR 835.202.

(1) A DOE ACL of 2 rem (0.02 Sv) total effective dose equivalent (TEDE) per year shall be implemented. No individual shall be permitted to receive an occupational exposure during planned activities that would result in exceeding the DOE ACL without the specific written authorization of the cognizant Secretarial Officer or designee.
(2) A cumulative total effective dose equivalent (CTEDE) ACL of 1 rem (0.01 Sv) TEDE per year of age shall be implemented. When a radiological worker's CTEDE exceeds 1 rem TEDE per year of age, special ACLs shall be established during ensuing years as necessary to cause that individual's CTEDE to approach and, if possible, fall below 1 rem per year of age.
(3) A facility-specific ACL shall be approved each year by facility management to maintain radiological worker doses below the DOE ACL. Written authorization by facility management shall be required prior to allowing any radiological worker's dose resulting from planned activities to exceed the facility-specific ACL.

b. Work Authorizations

Authorizations to work in radiological areas shall be in accordance with the Radiological Protection Program, required by 10 CFR 835.101. This program, in part, shall describe a radiological work authorization program as specified in 835.501 which appropriately utilizes available work documents and procedures. The level of detail included in these documents shall be commensurate with the nature and magnitude of the hazard and complexity of the required controls.

c. Radiation Safety Training

(1) Radiation safety training for general employees, radiological workers, and radiological control technicians shall utilize those portions of the standardized core training materials published by DOE that are relevant to facility hazards and operations, augmented as necessary by site-specific materials. Documentation of satisfactory completion of the entire DOE standardized core course(s) shall be accepted by all DOE activities.
(2) Training requirements commensurate with the hazard within a posted area shall be completed prior to permitting an individual unescorted access to that area.

d. Posting

Any accessible area in which radioactive material is used, handled, or stored shall be posted with the words "Caution, Radioactive Material." The posting shall meet the requirements of 10 CFR 835.601. The following areas are exempt from this posting requirement:

(1) Areas containing ten or fewer sealed radioactive sources with activities below the accountability criteria established in Attachment 1;
(2) Areas containing only materials that are properly packaged and labeled for transport in conformance with Department of Transportation regulations or corresponding DOE directives and expected to enter into transportation in the immediate future (i.e., the current shift);
(3) Areas under continuous observation and control of an individual knowledgeable of and empowered to implement required access control measures;
(4) Areas posted as a radiological area in accordance with 10 CFR 835.603;
(5) Other areas posted with radiological warning signs meeting the criteria established in 10 CFR 835.601; and
(6) Areas containing radioactive materials in quantities below the site- or facility- specified posting threshold. This threshold shall be established at a level below that which is likely to cause any individual to receive a TEDE in excess of 0.1 rem in a year.

e. Control of Sealed Radioactive Sources

(1) Administrative procedures shall be developed and maintained to control sealed radioactive sources having values equal to or exceeding those in Attachment 1 (i.e., accountable sealed radioactive sources).
(2) Accountable sealed radioactive sources, or their storage containers or devices, shall be labeled with the standard radiation warning trefoil and the words, "Caution, Radioactive Material."
(3) An individual shall be designated to maintain control of assigned Accountable Sealed Radioactive Sources. Prior to being designated, the individual selected shall be trained as a radiological worker in accordance with 10 CFR 835.902 and instructed on site-specific source control procedures.

(4) Each accountable sealed radioactive source shall be inventoried at intervals not to exceed six months. A 2 month grace period may be used to accommodate scheduling needs. This inventory shall establish:
   (a) The physical location of each accountable sealed radioactive source;
   (b) The adequacy of associated postings and labels; and
   (c) The adequacy of storage locations, containers, and devices.

(5) Each accountable sealed radioactive source having an activity exceeding 0.005 μCi shall be subject to a source integrity test upon receipt, when damage is suspected, and at intervals not to exceed six months. A 6-week grace period may be used to accommodate scheduling needs. Source integrity tests shall be capable of detecting radioactive material leakage equal to or exceeding 0.005 μCi.

(6) Notwithstanding the requirements of paragraph 6.e.(5), an accountable sealed radioactive source is not subject to a periodic source integrity test if that source has been documented to have been removed from service. Such sources shall be stored in a controlled location, subject to periodic inventory as required by paragraph 6.e.(4) of this section, and subject to a source integrity test prior to being returned to service.

(7) Notwithstanding the requirements of paragraph 6.e.(4) and 6.e.(5), an accountable sealed radioactive source is not subject to periodic inventory and source integrity tests if that source is located in an area that is inaccessible to individuals due to operational or environmental constraints.

(8) An accountable sealed radioactive source found to be leaking radioactive material at a level exceeding 0.005 μCi shall be controlled in a manner that prevents the escape of radioactive material to the workplace.

f. Exposure of Minors. The exposure of minors during direct onsite access to a DOE site or facility shall be controlled such that the dose to the extremities, lens of the eye, and other organs and tissues does not exceed 10% of the corresponding occupational exposure limits established in 10 CFR 835.202. Appropriate monitoring of external and internal dose shall be performed to demonstrate compliance with these limits.

g. DOE Laboratory Accreditation Program. The DOE Laboratory Accreditation Program (DOELAP) shall be maintained consistent with the applicable DOE standards, and dosimetry programs shall be accredited at periodic intervals consistent with the standards. Additional guidance for the various program elements are contained in the DOELAP Technical Standard.

7. RESPONSIBILITIES.

a. Secretarial Officers. Authorize exposures that exceed administrative control levels stated in paragraph 6a(1).
b. Managers of Operations Offices. Ensure through the contracting officer that contractors implement radiation protection programs that conform to the requirements of paragraph 6 above and 10 CFR 835.

c. Contractors. Contractors that manage and operate DOE defense nuclear facilities and other contractors as determined by the contracting officer shall develop and implement radiological protection programs that conform to the requirements of paragraph 6, above.

8. REFERENCES. Title 10, Code of Federal Regulations, Part 835, *Occupational Radiation Protection*.
9. CONTACT. Questions concerning this Notice should be addressed to the Office of Worker Protection Programs and Hazards Management, EH-52, on (301) 903-2135.

**Values for Exemption of Sealed Radioactive Sources from Inventory and Source Integrity Tests**

Less than 300 μCi (10 MBq)

H-3, Be-7, C-14, S-35, Ca-41, Ca-45, V-49, Mn-53, Fe-55, Ni-59, Ni-63, As-73, Se-79, Rb-87, Tc-99, Pd-107, Cd-113, In-115, Te-123, Cs-135, Ce-141, Gd-152, Tb-157, Tm-171, Ta-180, W-181, W-185, W-188, Re-187, Tl-204

Less than 30 μCi (1 MBq)

Cl-36, K-40, Fe-59, Co-57, Se-75, Rb-84, Sr-85, Sr-89, Y-91, Zr-95, Nb-93m, Nb-95, Tc-97m, Ru-103, Ag-105, In-114m, Sn-113, Sn-119m, Sn-121m, Sn-123, Te-123m, Te-125m, Te-127m, Te-129m, I-125, La-137, Ce-139, Pm-143, Pm-145, Pm-147, Sm-145, Sm-151, Eu-149, Eu-155, Gd-151, Gd-153, Dy-159, Tm-170, Yb-169, Lu-173, Lu-174, Lu-174m, Hf-175, Hf-181, Ta-179, Re-184, Re-186m, Ir-192, Pt-193, Au-195, Hg-203, Pb-205, Np-235, Pu-237

Less than 3 μCi (100 kBq)

Be-10, Na-22, Al-26, Si-32, Sc-46, Ti-44, Mn-54, Fe-60, Co-56, Co-58, Co-60, Zn-65, Ge-68, Rb-83, Y-88, Zr-88, Zr-93, Nb-94, Mo-93, Tc-95m, Tc-97, Tc-98, Ru-106, Rh-101, Rh-102, Rh-102m, Ag-108m, Ag-110m, Cd-109, Sn-126, Sb-124, Sb-125, Te-121m, I-129, Cs-134, Cs-137, Ba-133, Ce-144, Pm-144, Pm-146, Pm-148m, Eu-148, Eu-150, Eu-152, Eu-154, Gd-146, Tb-158, Tb-160, Ho-166m, Lu-176, Lu-177m, Hf-172 Ta-182, Re-184m, Os-185, Os-194, Ir-192m, Ir-194m, Hg-194, Pb-202, Bi-207, Bi-210m, Cm-241

Less than 0.3 μCi (10 kBq)

Sr-90, Cd-113m, La-138, Hf-178m, Hf-182, Po-210, Ra-226, Ra-228, Pu-241, Bk-249, Es-254

Less than 0.03 μCi (1 kBq)

Sm-146, Sm-147, Pb-210, Np-236, Cm-242, Cf-248, Fm-257, Md-258

Less than 0.003 μCi (100 Bq)

Gd-148, Th-228, Th-230, U-232, U-233, U-234, U-235, U-236, U-238, Np-237, Pu-236, Pu-238, Pu-239, Pu-240, Pu-242, Pu-244, Am-241, Am-242m, Am-243, Cm-243, Cm-244, Cm-245, Cm-246, Cm-247, Bk-247, Cf-249, Cf-250, Cf-251, Cf-252, Cf-254

Less than 0.0003 μCi (10 Bq)

Ac-227, Th-229, Th-232, Pa-231, Cm-248, Cm-250

## 3. SELF-STUDY SCENARIOS/ACTIVITIES AND SOLUTIONS

### *Scenario 1*

A contractor source custodian was performing a routine six-month inventory of radiation sources. The custodian reviewed the source records and discovered that an old 20 Ci Cs-137 calibrator was last used by a researcher who wanted to adapt it for some experiments. The custodian called the researcher and was told that the researcher's funds were not renewed and that he had moved. Others in the laboratory were uncertain as to whether the calibrator was still there. The custodian notified the health physics staff, who went to the laboratory where the researcher had worked to attempt to locate the calibrator. The calibrator was found, partially dismantled, in a storage area next to the lab. The shielding around the source was still intact. A review of personnel monitoring records, for employees, who had worked in the lab for the last six months, did not indicate any unusual trends or information.

Discuss the potential hazards in this scenario and briefly reference some of the requirements of the listed Orders, notices, codes, and regulations pertinent to this situation. Also, discuss changes you would recommend (or require, as appropriate) that the facility make to its RPP.

***Scenario 2, Part A***

A DOE M&O contractor, whose primary missions involve medical research, training, and environmental assessments of formerly remediated sites, maintains four buildings that contain radioactive materials. The hazards associated with operations involving these materials are viewed as minimal and could be characterized as those similar to that in a hospital or academic research setting. The majority of the radioactive material at the contractor's facility consists of low-level alpha, beta, and beta-gamma sources; sealed gamma and neutron sources; and tritium and carbon-14 labeled compounds. The typical annual inventory is in the microcurie to millicurie range. In performing their mission for DOE, the M&O contractor's employees routinely receive occupational exposures that are less than 100 mrem annually.

The contractor's facility was established in the 1940s with a workforce of 100. The original facility design criteria was for medical research and training. Today, the contractor employs 1,000 full-time employees, 100 of which are monitored radiation workers. The facility is located in a small town with a population of approximately 30,000 and is 30 miles from a population center of approximately 300,000.

Discuss the factors that influence the scope and magnitude of this facility's documented RPP.

***Scenario 2, Part B***

Develop specific criteria to evaluate the readiness of this facility's RPP.

**Scenario Solutions**

***Scenario 1, Solution***
(Any reasonable paraphrase of the following is acceptable.)

Several potential radiation hazards exist in this scenario. Essentially, the contractor has lost control of a large source. While it does not appear that overexposures occurred, they very easily could have if circumstances had been only slightly different. For example, the calibrator could have been dismantled to the point that the source was exposed, or the dismantling process could have ruptured the source, adding potentially significant contamination concerns to the scenario. Furthermore, since workers in the lab were apparently unaware of the presence of the calibrator, it could have easily been cleared out as unwanted equipment and possibly lost. Even if the researcher had stayed, modifications to such a piece of equipment should be carefully planned and scrutinized for a potential breach of original safety features. It appears that this process was not being strictly controlled; otherwise, consequences of the researcher leaving would have been apparent to other personnel. Also, the researcher should not have been allowed to leave with the calibrator unaccounted for and in a partially dismantled state.

Sections from the following DOE documents are pertinent to the above scenario:

<u>10 CFR 835</u>

835.2(a): The laboratory is a controlled area.

835.3(b): Contractor management is responsible.

835.101(b): DOE may direct modifications to an RPP.

835.202: Were dose limits exceeded?

835.704(b): ALARA actions must be documented.

835.1001: Design features.

<u>Notice 441.2</u>

6e: Control of sealed radioactive sources.

Implementation Guides
The IGs are DOE's views on acceptable implementation and infer compliance with the requirements.

The following changes are appropriate:

- Per 10 CFR 835.1001, require strict control of equipment modifications for research purposes. Modifications should be planned (including potential new safety features) and approved. Maintenance personnel must be fully cognizant of not only existing safety features, the modification plan, and how it will affect the safety features, but also of the new safety features and their design. Part of the approval process should include periodic updates where problems can be identified and solved. If a change occurs, similar to the one in the scenario where the researcher left the facility, then radiation sources can be accounted for and safely secured.
- Require researchers who utilize radiation sources to account for all sources assigned to them before leaving the premises. The health physics staff should perform a visual inspection and survey of departing researchers' laboratories. These requirements are appropriate items for the site procedures. However, the requirements of 441.2 are not required to be included in the formal DOE approved RPP and may not be addressed there although they should be addressed in the generic site radcon program. The "program" is not visually referred to as the RPP as it is denoted in 10 CFR 835. The RPP is the document submitted to DOE.
- Recommend that the sealed radioactive source inventory of large sources (above a certain activity, for example) be performed at intervals shorter than six months. This could reduce the loss of large sealed sources and run up costs.

***Scenario 2, Part A Solution***
(Any reasonable paraphrase of the following is acceptable.)

The scope, magnitude, and effectiveness of a RPP will vary from site to site and facility to facility based on many factors. For this scenario, these factors include, but are not limited to:

Specific facility mission

- Training.
- Medical research.
- Assessments of formerly remediated sites.

Types and quantities of radioactive material in use at the site/facility

- A variety of radioactive materials, which emit alpha particles, beta particles, photon radiations (x-rays and gamma rays), and neutrons, are used at this facility.
- Microcurie to millicurie levels of radioactivity make up the majority of the facility's annual inventory.

Physical and chemical form of the radioactive material

- The majority of the radioactive material consists of radiolabeled tritium and carbon-14 for medical experiments and both sealed and unsealed sources for training and environmental purposes.

Physical location of the site/facility in relation to population centers

- The facility is located in a town of 30,000 and 30 miles from a population center of 300,000.

Size of the workforce

- The contractor employs 1,000 people.
- One hundred (10%) of these employees are monitored radiation workers.

Age of the facility

- The facility is in excess of 50 years old; therefore, the original design criteria are less stringent than current standards. DOE Order 6430.1A, *General Design Criteria,* should be examined to assist in overcoming any deficiencies that would lessen the effectiveness of the RPP.

***Scenario 2, Part B Solution***
(Any reasonable paraphrase of the following is acceptable.)

Evaluating the readiness of an RPP is a complex task that requires, among other things, the formulation of numerous criteria. As mentioned earlier, examining and utilizing the subparts in 10 CFR 835 in addition to the guidance found in the DOE *Radiological Control Manual* are positive steps towards accomplishing this objective.

The following subparts are noted in Part 835:

- Subpart A - General Provisions
- Subpart B - Radiation Protection Programs
- Subpart C - Standards for Internal and External Exposure

- Subpart D - [Reserved]
- Subpart E - Monitoring in the Workplace
- Subpart F - Entry Control Program
- Subpart G - Posting and Labeling
- Subpart H - Records
- Subpart I - Reports to Individuals
- Subpart J - Radiation Safety Training
- Subpart K - Design and Control
- Subpart L - Releases of Material and Equipment from Radiological Areas
- Subpart M - [Reserved]
- Subpart N - Accidents and Emergencies

Note that examining just the titles of these subparts raises, in most cases, issues and questions that can be used as a foundation for developing detailed criteria. Examining the sections that follow each particular subpart are of even greater assistance in this regard.

The DOE IGs are very useful guidance documents that should be utilized to develop criteria. The information provided in this reference alone can generate hundreds of general and detailed questions regarding the effectiveness and readiness of an RPP. The reader is encouraged to use the DOE IGs, 10 CFR 835, and other references that are available within the DOE complex to formulate relevant criteria.

The rest of the solution that follows is not intended to fully satisfy the supporting knowledge and skills noted under Competency 2.1. Rather, it serves as an example of particular areas and issues that likely would be of interest in an evaluation of an RPP such as the one described for the facility identified in the scenario. The intent, then, is to list a topic, identify an objective related to that topic, and then offer one or more criteria related to that objective. The reader should develop additional criteria either in the form of a statement or question.

**NOTE:** Because the DOE *Radiological Control Manual* is now considered a guidance document, the word "shall" has been replaced by "should" (or equivalent) in the following sections where it is referenced in formulating criteria.

**Topic: Characterization**

Objective: The potential radiation hazards for this facility have been adequately characterized, including radiation types and energies, and contamination potential.

Criteria:
1) Radiological monitoring of radiation exposure levels, contamination, and airborne radioactivity should be conducted to characterize workplace conditions and to identify areas requiring posting (DOE *Radiological Control Manual,* Article 551.1).

2) Assessment of radiological conditions should include a sufficient number of survey points to characterize the radiation present and to verify boundaries (DOE *Radiological Control Manual,* Article 551.6).

3) For external radiation, the types, energies, and spatial distribution of radiation sources should be identified. Other considerations may include the time spent in specified exposure conditions, training of workers for specific tasks, the degree of supervision, and the general layout of the working area *(International Atomic Energy Agency [IAEA] Safety Series No. 14,* Section 3.4.1).

**Topic: ALARA Review**

Objective: An ALARA evaluation has been performed including person-rem estimates for each evolution of the process or category of worker. This evaluation has been documented.

Criteria:
1) Formal plans and measures should be used to ensure that occupational radiation exposures are maintained ALARA (DOE 10 CFR 835, Subpart B, Section 835.101).

2) Technical requirements for the conduct of work, including construction, modifications, operations, maintenance, and decommissioning, should incorporate radiological criteria to ensure safety and maintain radiation exposures ALARA. To accomplish this, the design and planning processes should incorporate radiological considerations in the early planning stages. The checklist in Appendix 3A of the DOE *Radiological Control Manual* is helpful in reducing occupational radiation exposure (DOE *Radiological Control Manual,* Section 311).

**Topic: Engineered Controls**

Objective: Appropriately designed engineered controls have been incorporated. These controls are documented.

Criteria:
1) The enclosure system, including its internal and external support structures, should be designed to withstand the effects of normal operating conditions and the environment (DOE Order 6430.1A*, General Design Criteria,* Section 1161*).*

2) Engineering controls, including containment of radioactive material at the source wherever practicable, should be the primary method of minimizing airborne radioactivity and internal exposure to workers (DOE *Radiological Control Manual,* Article 316.1).

3) Engineering controls, such as containment devices, portable or auxiliary ventilation, and temporary shielding, should be installed in accordance with the technical work documents and inspected prior to use (DOE *Radiological Control Manual*, Article 342.4).

4) Processes and activities with the potential for producing airborne radioactivity should include engineering controls to limit releases (DOE *Radiological Control Manual,* Article 453.1).

**Topic: Instrumentation**

Objective: The radiation monitoring instrumentation (air monitoring, contamination monitoring, and direct survey equipment) selected for use is appropriate for the radiation hazards identified.

Criteria: 1) Appropriate stationary (area) and/or portable radiation monitoring instruments should be available and used to measure dose rates for the purpose of controlling exposure to radiation. These instruments should be routinely calibrated and maintained. The combination of instruments used should provide the capability to measure types of radiation and dose rates characteristic of that which could be encountered at that facility (10 CFR 835, Subpart E, Section 835.401).

2) Instruments and techniques used to provide contamination monitoring and control should be adequate to ensure compliance (10 CFR 835, Subpart E, Section 835.404).

3) Instruments used to perform radiation surveys should be response-checked daily or prior to operation. When response checks are not within ± 20 percent of the expected value, the instrument should be taken out of service. When response checks are not feasible, such as with instruments used to measure neutrons or tritium, compensatory actions should be established to ensure proper instrument performance (DOE *Radiological Control Manual,* Article 551.5).

4) Radiological instruments should be used only to measure the radiation for which their calibrations are valid. DOE Order 5480.4 mandates the requirements contained in American National Standards Institute N 323 for radiological instrumentation calibration. Calibrations should use National Institute of Standards and Technology (NIST) traceable sources (DOE *Radiological Control Manual*, Article 562.1).

**Topic: Radiological Surveys**

Objective: Routine radiological surveys (contamination, airborne radioactive materials, and direct radiation) for this operation are defined and are adequate to detect potential increases in radiation hazards.

Criteria:

1) Occupational workers should be monitored, as appropriate, to demonstrate compliance with the regulations. Workplaces should be routinely monitored, as appropriate, for identification and control of potential exposure sources (10 CFR 835, Subpart E, Section 835.401).

2) Surveys for radiation, contamination, and airborne radioactive materials should be performed as specified in technical work documents and RWPs (DOE *Radiological Control Manual,* Article 551.3).

3) Survey frequencies should be established based on potential radiological conditions, probability of change in conditions, and area occupancy factors (DOE *Radiological Control Manual,* Article 551.8).

**Topic: External Dosimetry**

Objective: Personnel dosimetry is adequate for the radiation hazards associated with this facility.

Criteria:

1) Personnel external dosimetry programs should be adequate to demonstrate compliance. Personnel dosimeters should be routinely calibrated (10 CFR 835, Subpart E, Section 835.402).

2) The DOE Laboratory Accreditation Program (DOELAP) should be maintained consistent with the applicable DOE standards, and dosimetry programs should be accredited at periodic intervals consistent with the standards (DOE Notice 441.2, Section 6g).

**Topic: Internal Dosimetry**

Objective: Internal dosimetry considerations have been evaluated and baseline data are available for the workers associated with this facility.

Criteria:

1) Internal dose evaluation programs (including routine bioassay programs) should be adequate to demonstrate compliance (10 CFR 835, Subpart E, Section 835.402).

2) Baseline bioassay monitoring of personnel who are likely to receive intakes resulting in a committed effective dose equivalent greater than 100 mrem should be conducted before personnel begin work that may internally expose them to radiation (DOE *Radiological Control Manual*, Article 522.2).

**Topic: Personnel Protective Equipment and Controls**

Objective: Adequate personnel protective equipment (including protective clothing) and controls are available.

Criteria:

1) Personnel who work in a hazardous environment (e.g., an environment subject to radioactive gases and airborne particulates) or who may be temporarily exposed to such hazards should have convenient access to the appropriate protection equipment, including proper garments, equipment such as emergency showers and eyewashes, and any other protective equipment necessary for the successful and safe completion of their work *(*DOE Order 6430.1A, Section 1300-12.4.5*).*

2) The following controls apply to glove box operations (DOE *Radiological Control Manual,* Article 347.4*)*:

   a. Glove boxes should be inspected for integrity and operability prior to use.

   b. Glove boxes should be marked or survey measurements should be posted to identify whole body and extremity dose rates.

   c. Protective clothing shall, at a minimum, include lab coats and gloves. Gloves should be secured at the wrist as necessary.

   d. Shoe covers should be considered based on the potential for floor contamination.

   e. Workers should periodically monitor their hands during work.

   f. Upon completion of work or prior to leaving the area, workers should monitor those areas of their bodies that are potentially contaminated. At a minimum, this includes hands, arms, and feet. Workers should perform a whole-body frisk.

**Topic: Work Procedures**

Objective: Work procedures have been reviewed by radiation safety professionals and have the appropriate radiation protection hold points, trigger points, and actions identified.

Criteria:

1) The site-specific radiological control manual should establish trigger levels requiring formal radiological review of nonroutine or complex work activities. These appropriate trigger levels, taken from the DOE *Radiological Control Manual,* Article 312.3, should include:

   a. Estimated individual or collective dose greater than preestablished values.

   b. Predicted airborne radioactivity concentrations in excess of preestablished values.

   c. Work area removable contamination greater than 100 times the values in Table 2-2 of the DOE *Radiological Control Manual.*

d. Entry into areas where dose rates exceed 1 rem/hour.

e. Potential radioactive releases to the environment.

2) Tasks with the potential to exceed the above trigger levels should undergo a formal, documented radiological or ALARA review. This review should consider the following (DOE *Radiological Control Manual,* Article 312.4):

a. Inclusion of radiological control hold points in the technical work documents.

b. Elimination or reduction of radioactivity through line flushing and decontamination.

c. Use of work processes and special tooling to reduce time in the work area.

d. Use of engineered controls to minimize the spread of contamination and generation of airborne radioactivity.

e. Specification of special radiological training or monitoring requirements.

f. Use of mock-ups for high exposure or complex tasks.

g. Engineering, design, and use of temporary shielding to reduce radiation levels.

h. Walkdown or dry-run of the activity using applicable procedures.

i. Staging and preparation of necessary materials and special tools.

j. Maximization of prefabrication and shop work.

k. Review of abnormal and emergency procedures and plans.

l. Identification of points where signatures and second-party or independent verifications are required.

m. Establishment of success or completion criteria, with contingency plans to anticipate difficulties.

n. Development of a pre-job estimate of collective dose to be incurred for the job.

o. Provisions for waste minimization and disposal.

3) Radiological work activities should be conducted as specified by the controlling technical work document and radiological work permit (DOE *Radiological Control Manual,* Article 341.1).

**Topic: Radiological Maintenance**

Objective: The performance of expected maintenance has been reviewed for radiological concerns, and appropriate controls are in place.

Criteria:

1) Ease of maintenance and decontamination and decommissioning is to be considered in facility design and selection of materials (10 CFR 835, Subpart K, Section 835.1002).

2) Technical requirements for the conduct of work, including construction, modifications, operations, maintenance, and decommissioning, should incorporate radiological criteria to ensure safety and maintain radiation exposures ALARA (DOE *Radiological Control Manual,* Article 311).

3) Maintenance and modification plans and procedures should be reviewed to identify and incorporate radiological requirements, such as engineering controls and dose and contamination reduction considerations (DOE *Radiological Control Manual*, Article 312.1).

4) Preventive maintenance and surveillance procedures should be established to ensure that equipment controls are maintained in an operable condition for containment of airborne radioactivity (DOE *Radiological Control Manual,*Article 453.3).

**Topic: Radiological Emergencies**

Objective: Potential radiological emergencies are planned for in the design of support equipment, and documented action plans/procedures are in place.

Criteria:

1) The site-specific radiological control manual should establish trigger levels requiring formal radiological review of nonroutine or complex work activities. These appropriate trigger levels should include (DOE *Radiological Control Manual*, Article 312.3):

   a. Estimated individual or collective dose greater than preestablished values.

   b. Predicted airborne radioactivity concentrations in excess of preestablished values.

   c. Work area removable contamination greater than 100 times the values in Table 2-2 of the DOE *Radiological Control Manual*.

   d. Entry into areas where dose rates exceed 1 rem/hour.

   e. Potential radioactive releases to the environment.

2) Tasks with the potential to exceed the above trigger levels shall undergo a formal, documented radiological or ALARA review. At a minimum, this review should consider abnormal and emergency procedures and plans (DOE *Radiological Control Manual,* Article 312.4).

**Topic: Roles and Responsibilities**

Objective: Roles and responsibilities concerning radiation protection have been clearly identified and communicated.

Criteria:

1) Radiological control technicians and their supervisors should have the responsibility and authority to stop work or mitigate the effect of an activity if they suspect that the initiation or continued performance of a job, evolution, or test will result in the violation of radiological control standards or result in imminent danger or unacceptable risk. Any worker, through his/her supervisor, also has stop-work authority in accordance with Article 345 (DOE *Radiological Control Manual,* Article 144.2).

2) Good radiation safety practice depends on an effective health and safety organization. Experience shows that even the most competent worker cannot be relied upon to keep in mind all health and safety requirements while preoccupied with the successful performance of his/her work. Responsibilities and duties must be set out clearly to ensure safety *(IAEA Safety Series No. 1,* Section 1.4.1).

3) The lines of responsibility in all matters connected with radiation safety should be very clearly drawn, and each individual should be aware of his/her duties and responsibilities *(IAEA Safety Series No. 38,* Section 21.2.4).

**Topic: Training**

Objective: Workers have received the appropriate training, including Radiological Worker training and job-specific radiation protection and monitoring criteria.

Criteria:

1) The training should emphasize procedures specific to an individual's job assignment (10 CFR 835, Subpart J, Section 835.902).

2) Radiological Worker II training is warranted for entry into areas as stated in Table 6-1 of the DOE *Radiological Control Manual*. Additional training should be strongly considered for special job functions with radiological consequences (DOE *Radiological Control Manual*, Article 631.2*)*.

3) Workers whose job assignments involve entry to high- and very high-radiation areas, contamination areas, high-contamination areas, and airborne radioactivity areas should complete Radiological Worker II training. Further, workers who have potential contact with hot particles or use of glove boxes with high contamination levels should complete Radiological Worker II training (DOE *Radiological Control Manual*, Article 632.1).

4) Monitoring should be performed only by trained and qualified personnel using properly calibrated instruments (DOE *Radiological Control Manual*, Article 551.2).

**Topic: Internal Audits**

Objective: An internal audit program is developed and appropriate for review of the facility's operations.

Criteria:

1) Contractor internal audits of all functional elements of the RPP shall be conducted no less frequently than every 36 months and shall include program content and implementation (10 CFR 835, Subpart B, Section 835.102).

2) The internal appraisal system shall provide for objective and independent review of environment, safety, and health functions to determine that they are conducting reviews of: (1) proposed modifications to plant and equipment having safety significance; (2) proposed experiments and results thereof having safety significance; (3) procedures and significant changes to administrative, operating (normal and abnormal) maintenance, quality assurance (as it applies to Subparagraph 7), and emergency; (4) organizations and staffing of each facility; (5) operating limits, changes thereto, and violations thereof; (6) operator and supervisor training programs, certification, and decertification standards and procedures; and (7) accidents, incidents, and unusual occurrences (DOE Order 5482.1B, Section 09.D[2][G]).

**Topic: Records**

Objective: Radiation monitoring and protection standards are adequate and appropriate.

Criteria:

1) Records associated with the RPP shall be generated and maintained (10 CFR 835, Subpart H, Section 835.701).

2) Radiological records should be in accordance with the DOE *Radiological Control Manual*, Chapter 7.

## 4. SUGGESTED ADDITIONAL READINGS AND/OR COURSES

*Readings*

- 10 CFR 835, *Occupational Radiation Protection*.
- DOE N441.1*, Radiation Protection for DOE Activities*.
- DOE Order 5400.5, *Radiation Protection of the Public and Environment*.
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*.
- DOE Order 5480.6, U.S. Department of Energy, 1986. *Safety of Department of Energy-Owned Nuclear Reactors*. Washington, D.C.
- U.S. Department of Energy. 1980. *A Guide to Reducing Radiation Exposure to As Low As Reasonably Achievable (ALARA)*, DOE/EV/1830-T5. Washington, D.C.
- U.S. Department of Energy. 1988. *Health Physics Manual of Good Practices for Reducing Radiation Exposure to As Low As Reasonably Achievable (ALARA)*. PNL-6577. Pacific Northwest Laboratory. Richland, Washington.
- U.S. Department of Energy. 1988. *Records Disposition.* DOE Order 1324.2A. Washington, DC.
- U.S. Department of Energy. 1989. *General Design Criteria.* DOE Order 6430.1A. Washington, D.C.
- U.S. Department of Energy. 1990. *Final Report to the Secretary of Energy: Implications of the BEIR V Report to the Department of Energy.* DOE/EH-0158T.
- U.S. Department of Energy. 1992. *Occupational Dose Reduction at Department of Energy Contractor Facilities: Study of ALARA Programs - Good Practice Documents.* DOE/EH-0278T. Washington, D.C.
- Office of Health Implementation Guides for use with Title 10 CFR Part 835.
- Price-Anderson Amendments Act (PAAA) of 1988.
- NCRP Report 95, *Radiation Exposure of the U.S. Population from Consumer Products and Miscellaneous Sources.*

*Courses*

*Radiation Protection Functional Area Qualification Standard*--GTS Duratek.